Aerosol distribution in the Northern Hemisphere during ACE-Asia: Results from global model, satellite observations, and Sun photometer measurements

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[1] We analyze the aerosol distribution and composition in the Northern Hemisphere during the Asian Pacific Regional Aerosol Characterization Experiment (ACE-Asia) field experiment in spring 2001. We use the Goddard Chemistry Aerosol Radiation and Transport (GOCART) model in this study, in conjunction with satellite retrieval from the Moderate-Resolution Imaging Spectroradiometer (MODIS) on EOS-Terra satellite and Sun photometer measurements from the worldwide Aerosol Robotic Network (AERONET). Statistical analysis methods including histograms, mean bias, root-mean-square error, correlation coefficients, and skill scores are applied to quantify the differences between the MODIS $1° \times 1°$ gridded data, the daytime average AERONET data, and the daily mean $2° \times 2.5°$ resolution model results. Both MODIS and the model show relatively high aerosol optical thickness (τ) near the source regions of Asia, Europe, and northern Africa, and they agree on major features of the long-range transport of aerosols from their source regions to the neighboring oceans. The τ values from MODIS and from the model have similar probability distributions in the extratropical oceans and in Europe, but MODIS is approximately 2–3 times as high as the model in North/Central America and nearly twice as high in Asia and over the tropical/subtropical oceans. Comparisons with the AERONET measurements in the Northern Hemisphere demonstrate that in general the model and the AERONET data have comparable values and similar probability distributions of τ, whereas MODIS tends to report higher values of τ over land, particularly North/Central America. The MODIS high bias is primarily attributed to the difficulties in land algorithm dealing with surface reflectance over inhomogeneous and bright land surfaces, including mountaintops, arid areas, and areas of snow/ice melting and with land/water mixed pixels. The model estimates that on average, sulfate, carbon, dust, and sea salt comprise 30%, 25%, 32%, and 13%, respectively, of the 550-nm τ in April 2001 in the Northern Hemisphere, with ~46% of the total τ from anthropogenic activities and 66% from fine mode aerosols. *INDEX TERMS:* 0305 Atmospheric Composition and Structure: Aerosols and particles (0345, 4801); 0368 Atmospheric Composition and Structure: Troposphere—constituent transport and chemistry; 0345 Atmospheric Composition and Structure: Pollution—urban and regional (0305); *KEYWORDS:* aerosols, distributions, ACE-Asia

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1. Introduction

[2] The Asian Pacific Regional Aerosol Characterization Experiment (ACE-Asia), which studied the characteristics of aerosols from Asia and their radiative effects, took place in spring 2001 in the western Pacific region near the east coast of Asia. In the spring, dust emission in northern Asia is strong, biomass burning in Southeast Asia is at its peak, photochemical production of pollution aerosols is active, and the continental outflow from Asia to the western Pacific is at its strongest. In other words, the timing of ACE-Asia was optimal for studying the impact of maximum Asian aerosol concentrations on